

REMARKS

Favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

The claims have been amended to remove the preamble recitation "pressure kneaded". Although the Applicants respectfully disagree with the position taken by the Examiner in the Action, the recitation has been removed to expedite allowance. Furthermore, the recitation "consisting essentially of" has been returned to the original recitation "comprising". While the Applicants respectfully disagree with the positions of the Examiner with respect to this phrase, the phrase has been removed to expedite allowance.

To further distinguish the claimed invention from the prior art, claim 1 has been amended to cite that the resin composition is kneaded with a pressure kneader under a pressure of 9.8×10^3 to 9.8×10^5 Pa higher than atmospheric pressure. See page 25, lines 2-3 of the specification. Claim 1 has been further amended to recite that the weight ratio of the electroconductive agent to the radical-polymerizable thermosetting resin system is 65/35 to 92/8. See page 18, line 18 of the specification.

Claim 11 has been amended to recite that the monomer is an optional component. This is obvious from the description of the specification that the weight ratio of the radical-polymerizable resin to the monomer can have the ratio of 100/0. See original claim 11 and page 18, lines 8-10 of the specification.

In view of the foregoing amendments, the rejection of claims 1-19 under 35 U.S.C. 112, second paragraph is deemed to be overcome. In addition, the rejection of the claims under 35 U.S.C. 132 on the basis of new matter is deemed to be overcome, although the Applicants respectfully disagree with the position of the Examiner.

Claims 1-3, 9-10 and 16-18 are rejected under 35 U.S.C. 102 as anticipated by U.S. Patent No. 4,301,222. Claims 1-19 are further rejected under 35 U.S.C. 103 as obvious over U.S. Patent No. 6,251,308 in view of the '222 patent. These grounds of rejection are respectfully traversed as applied to the claims after the foregoing amendments.

Emanuelson et al. discloses "an electrochemical cell separator plate having a thickness no greater than 0.150 inch and having been made by molding and then heat treating a mixture comprising high purity graphite powder and a carbonizable thermosetting phenolic resin in a proportion 45-65 parts by weight graphite and 55-35 parts by weight resin, said graphite powder consisting of substantially 100% fully graphitic particles having a density of at least 2.0 gm/cc, an average aspect ratio of less than about 0.40, and a distribution of particle sizes up to a maximum of about 230 microns, with between 31 to 62 weight percent of the particles having a size less than 45 microns, said resin having a carbon yield of at least 50%, said finished plate having been graphitized to at least 2100°C and having an initial threshold corrosion potential at 400°F of at least 1,000 millivolts, a maximum initial thru-plane electrical resistivity of 0.011 ohm-cm, an initial flexural strength at 400°F of at least 4000 psi and an electrolyte take-up no greater than 5.0%" (claim 1).

Regarding the resin contents, Emanuelson et al. describes "Laboratory test data on plate sections heat treated to 2100°C (the lowest acceptable graphitizing temperature) and having resin contents of 40 or 50%, demonstrate significantly improved properties when compared to plates made with 20 or 30% resin. For example, flexural strength with 50% resin is approximately twice that with 20% resin. Hydrogen permeability and ETU for plates made with 20 or 30% resin can be expected to have about three times the hydrogen permeability and ETU of plates made with 40 or 50% resin" (column 6, lines 46-57). Further, "To fabricate a separator plate a well blended mixture of the appropriate resin and graphite powder, as described above, is distributed in a mold. This molding compound is compacted under pressure and temperature to melt and partially cure the resin and produce material flow such that the desired thickness and the desired density of 97-99% of the maximum theoretical density for the particular graphite/resin mixture used has been attained" (column 9, lines 15-23).

Regarding the advantages of Emanuelson et al., there is described "separator plates for these cells . . . meet high standards in terms of many different characteristics or properties such as: (1) hydrogen permeability; (2) corrosion resistance; (3) electrical resistivity; (4) thermal conductivity; (5) strength; and (6) electrolyte absorption resistivity" (column 4, lines 36-41).

Butler discloses "A composition comprising:

- a) an unsaturated prepolymer resin which comprises one or more of unsaturated polyester and vinyl ester resin;
- b) an unsaturated material copolymerizable with said resin and including a terminal ethylene group;
- c) at least 50% by total weight of the composition comprising an conductive filler;
- d) an initiator to initiate said copolymerization; and
- e) an effective amount of a rheological modifier to prevent phase separation between said resin and said conductive filler during molding, said rheological modifier being one or more compositions selected from the group consisting of Group II oxides and hydroxides, carbodiamides, aziridines, polyisocyanates, polytetrafluorethylene, perfluoropolyether, polyethylene and fumed silica, and clays" (claim 1).

Regarding conductive fillers, Butler et al. describes "A preferred filler is graphite particles" (column 4, lines 41-42), "Desirably conductive fillers are at least about 50, about 60, or about 65 weight percent of the molding composition. More desirably, the filler is more than about 70 or 71 percent to about 78 weight percent of the molding composition" (column 4, lines 56-60). Further, with regard to an unsaturated prepolymer, "vinyl ester resins are the reaction product of an epoxy terminated oligomer, for example, an epoxy functionalized bisphenol A with an acrylic acid, or methacrylic acid forming acrylic terminal groups on the oligomer" (column 4, lines 18-21). Regarding the copolymerizable unsaturated monomer, "this component is capable of dissolving the resin component at room temperature. . . . Examples of suitable monomers are styrene . . . The ratio of monomer(s) to resin is desirably from about 40:60 to about 75:25 and preferably from about 40:60 to about 65:35 by weight" (column 4, lines 27-37). Regarding a low-profile agent, "Other optional components to a molding composition include . . . low shrinkage additives like polyvinyl acetate or polyethylene" (column 6, lines 38-41).

Furthermore, "The molding compositions may be formulated and mixed using a variety of mixing conditions including either continuous or batch and using a variety of known mixing equipment" (column 6, lines 61-64).

Regarding advantages of Butler, there describes "Molded products made from the compositions of the present invention are useful for a variety of applications demanding complex configurations, conductivity, as well as strength, and corrosion resistance. One particularly advantageous product which can be made by compression molding is a bipolar plate for use in fuel cells" (column 7, lines 19-23).

However, the references fail to disclose or suggest the claimed resin composition comprising the electroconductive agent and the radical-polymerizable thermosetting resin system which is kneaded with a pressure kneader under the specific claimed pressure. In particular, the references fail to teach an important role of the kneaded composition in relation to the properties of the separator.

Emanuelson et al. fails to disclose or suggest kneading the resin composition with a pressure kneader under the specific claimed pressure. Further, the reference fails to disclose a radical-polymerizable thermosetting resin, since the thermosetting phenolic resin of the reference is classified as a condensing-curable resin.

Butler also fails to disclose or suggest kneading the resin composition with a pressure kneader under the specific claimed pressure and thus a rheological modifier is required in the reference composition for improving the moldability of the resin composition containing much conductive filler.

Incidentally, although the Examiner pointed out that the range of pressure of the former claim includes 1 atmosphere (standard room pressure), it should be noted that the pressure is defined, on page 25, lines 1-5 of the specification, as a unit "kgf/cm²" which means a pressure (kgf) applied to a unit area (cm²). Namely, the pressure represents a pressure higher than atmospheric pressure applied to the composition in the kneader.

Accordingly, since the references fail to disclose or suggest the combination of the specific claimed kneading conditions and the claimed high carbon content-composition, the claimed resin composition is not suggested by the references.

Moreover, the present invention provides unexpected advantages. That is, Emanuelson et al. refers to the weight ratio of graphite to the carbonizable thermosetting phenolic resin of 65/35 to 45/55, and recites that flexural strength, hydrogen permeability and electrolyte take-up for plates containing the resin of 20 or 30% by weight are inferior to those for plates containing the resin of 40 or 50% by weight. Accordingly, Emanuelson et al. suggests that the resin composition containing the graphite in a proportion of more than 65% by weight can not improve flexural strength and other properties. Further, Butler teaches that the moldability of the resin composition containing much conductive filler can not be improved without using the rheological modifier.

On the other hand, according to the present invention, moldability of electroconductivity, mechanical strength, gas-perviousness, durability, and dimensional accuracy of the resin composition can be improved even with a high content of the electroconductive agent and without using a rheological modifier.

Furthermore, the resin compositions of the references are obtained with a conventional mixing equipment under atmospheric pressure. Thus, the composition of the references seem to correspond to the composition of Example 5 described on page 31 of the present application (i.e., the composition kneaded with a conventional kneader under atmospheric pressure). On the other hand, Example 6 described on page 32 of the application corresponds to the present invention, since the composition of Example 6 is obtained in similar manner to Example 5 except for pressurized-kneading with the use of a pressure kneader. Thus, the comparison of Bending Strength, Thermal conductivity, Shrinkage Rate, and Warp of the mold article of Example 5 with those of the article of Example 6, mainly based on Table 2 of the present application, are shown below.

	Kneaded Compound	Kneading	Bending Strength [kg/mm ²]	Thermal conductivity [W/(m•K)]	Shrinkage Rate (%)	Warp
Ex. 5	Coarse particulate	Atmospheric Pressure	6.1	31	0.05	4.1
Ex. 6	Clay-like or viscous	Pressurized	6.5 (7% up)	36 (16% up)	0.04 (20% down)	3.2 (22% down)

As apparent from the table, Bending Strength and Thermal conductivity of Example 6 are improved by about 7% and 16% respectively, in comparison with those of Example 5, and Shrinkage Rate and Warp of Example 6 are improved by about 20% and 22% respectively, in comparison with those of Example 5. Namely, although Example 6 is the same composition as Example 5, Example 6 is extremely improved in these properties relative to Example 5. Thus, these improvements could never be expected from the references.

Further, since the kneaded compound of Example 5 is coarse particulate and a uniform compound is not formed, not only handling and operability of the compound is deteriorated but also the molded article has a small defects at the edge portion. On the other hand, since the pressurized kneading of the claimed invention provides a viscous or clay-like uniform compound as apparent from Example 6, handling and operability of the pressurized kneaded compound is improved and thus the molded article made from the claimed composition has uniformity all over and no defects such as voids at the edge portion.

Further, since the composition of Emanuelson et al. contains small amounts of the electroconductive agent, the molded article of Emanuelson has low electroconductibility. Furthermore, since the composition of Butler contains the rheological modifier such as metal oxides, metal hydroxides, carbodiamides, aziridines and the others, and since acid-resistance is required for a fuel cell, the molded article of Butler has low durability such as acid-resistance.

Thus, these advantages of the present invention are not suggested by the references.

In view of the foregoing, it is respectfully submitted that the claimed composition is neither disclosed nor suggested by the cited references, and favorable reconsideration and allowance is respectfully solicited.

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